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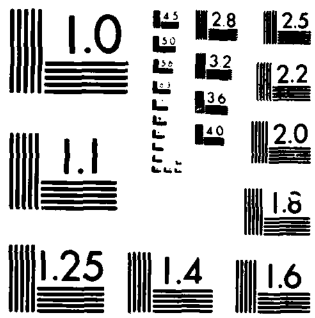

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FOREIGN TECHNOLOGY DIVISION

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by

Yoshiyasu Kyotani

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MINI-SPECIAL

IV. THE CURRENT STATUS ON THE OVERSEAS DEVELOPMENT OF MAGNETIC SUSPENSION RAILROADS

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1. *INTRODUCTION*

For describing the current status on the overseas development of magnetic suspension railroads, a convenient way is to discuss either according to different countries or according to different magnetic suspension methods. Our discussion will be made following the former classification.

Although relevant technical data are referenced as much as possible here, I feel that they are still insufficient. Therefore, it is dangerous to judge the stage of the development among various countries from this article alone. I would like to warn readers that this article is written based on my own literature survey and interpretation.

In the initial development stages, it is important to show product feasibility. This stage of course produces a large amount of information. In the later development stages, in which its market prospect becomes clearer, it is generally inevitable that the information gets fragmented. indicating a transition from the realm of science to the development of a commercial product. On the other hand, there will be failed cases and therefore long-term information collection and its analysis will be essential to grasp the implication of the development stages.

2. *CANADA*

Research and development of the superconductor magnetic suspension linear synchronous motor (LSM) propulsion system as a possible use for high-speed mass transportation between major cities has been steadily in progress. The basic experiments and their theoretical analysis have

already been completed. Using these results, a conceptual design of the superconductor magnetic suspension railroad was done. At present, researchers are evaluating performance of the total system. In this project, they attempt to estimate the amount of energy consumption from an air resistance experiment in a wind tunnel. In addition, an analysis for the car dynamics of the support system is further carried out using the detailed design of the support and the structural accuracy of the guideway.

Since they thought that a superconductor magnet is one important structural element in the entire development, a realistic plan for its trial production, experiment, and performance evaluation has been made. A target date for initiating the production of a trial superconductor magnet is projected to be the end of this year. The cryogenic helium system for the magnet is mounted on a car. The niobium-tin compound in the form of multi-filaments is employed for its wire material. Furthermore, a removable power lead and a permanent current switch will be used for the magnet. However, they might first proceed to a trial production of an open-type superconductor magnet, which is made of niobium-titanium alloy wires. A decision as to which wire material is adopted and how the low temperature is maintained for the magnet has to wait until the end of this year and its consequence may be noteworthy.

The cost feasibility study is also made and will be completed this year.

Research on the normal conductor suction-type system is already done and currently their efforts are focused on the development of a linear induction motor (LIM).

3. WEST GERMANY

For the magnetic suspension systems, the normal conductor suction-type magnetic suspension and the superconductor magnetic suspension methods are selected as the subjects of research and development, whereas, for the linear motor propulsion system, LIM, iron-core LSM, and hollow-core LSM (using a superconductor magnet) are chosen. The first phase of the superconductor magnetic suspension project is already finished and now the emphasis is on the normal conductor suction-type magnetic suspension for the suspension method and on iron-core

LSM and hollow-core LSM for the linear motor.

A railroad combining both the normal conductor suction-type magnetic suspension and the iron-core LSM is being exhibited at this year's International Transportation Fair in Hamburg. This facility is built to demonstrate the guideway technique that supplies a power to the ground side (called an active guideway) and its linear motor propulsion system. They are showing at two locations (~908m far apart) in a two-compartment car, which weighs 36 tons and carries a seating capacity of 68. The drive speed is 75 km/h and its maximum drive force 28 kN. A magnet for the support also uses the excitation magnet of LSM.

These results will be soon compiled and evaluated. Nevertheless, it is significant to note the achievement that the use of the active guide can meet its cost requirement.

An experiment on the hollow-core LSM is currently conducted. Some questions, however, remain as to why the researchers ended their research and development on the superconductor magnetic suspension without waiting for experimental results from the hollow-core type LSM having a superconductor magnet.

4. ENGLAND

In England, four systems are subjects of investigation for the magnetic suspension railroads. These four systems include the normal conductor suction-type magnetic suspension railroad, which operates driving and suspension either independently or together, the superconductor magnetic suspension railroad, and the mixed μ-type magnetic suspension railroad. For the first system, three research groups have been working independently. In the near future, however, they will collaborate on projects involving detailed studies of the suspension and propulsion, the mutual influence of the suspension and propulsion, and finally discussions of the dividers.

The second system is considered as a possible use for mass transportation in suburban areas. While LIM is emphasized in the first system, both LIM and LSM are discussed in the second system.

The third system, for which a linear commutator motor was originally used for propulsion, employs a sheet of superconductor magnetic suspension together with LSM propulsion. A basic in-door experiment has been completed and an outdoor aerodynamic experiment using a model car is being conducted before preparing for a superconductor magnetic suspension LSM propulsion experiment. A superconductor magnet for this experimental car has already been manufactured but will be investigated for further development.

The fourth method, the mixed μ-type, has evolved from research work made on stability during magnetic suspension. A symbol, μ, denotes a permeability and this method uses the minus effect in a superconducting state. Researchers just finished the basic experiments and few related data have been reported. The characteristics of this method is that the support and guide are done using existing iron rails. However, the propulsion requires totally different systems.

5. AMERICA

In America, the research and development are aimed at marketing medium low-speed or high-speed cars. So far, considerable funds have been invested for developing various types of suspension railroads.

For the superconductor magnetic suspension system, a basic experiment and trial production has been completed, and an emphasis is currently placed on research on linear motors. For the normal conductor magnetic suspension system, a combined propulsion/suspension method is considered and an experiment for determining the allowable maximum speed is conducted. These results may be reported shortly.

Since the charter of the department of transportation changed frequently and sometimes even moved to other departments, it is difficult to grasp totally how the development of the magnetic suspension railroad is. However, after the research and special program agency (RSPA) was established in 1978, it started to get actively involved in research in collaboration with the federal railway authority, the department of energy, and their other related departments.

For the superconductor magnetic suspension system, an experiment on stability during the connection of two cars is being conducted using a rotating set-up. These data have been gradually accumulated. The rotary set-up is also used for LSM and the goal is to achieve 500km/h. These results are compared and evaluated with those of SLIM (one-side type LIM).

A study of riding comfortableness on the magnetic suspension railroad is compared with other methods. In particular, to cut the production cost of the guideway in the normal conductor suction-type system, the tolerance, suspension characteristics, and riding comfortableness are critically evaluated.

To provide useful information on future research and development, RSPA is reevaluating conditions necessary for future transportation vehicles from the point of energy, transportation capacity, and cost.

6. SOVIET UNION

Research initiated in 1976 is to find out the prospect and development goal of high-speed ground transportation vehicles by the year of 2000 and is expected to finish by 1980. For the linear motor, a wide range of research and development on SLIM, iron-core LSM, and hollow-core LSM have been conducted. By aiming at 500km/h as a target speed, researchers are conducting a study of the power supply and power collection. For the magnetic suspension, a repulsion using a permanent magnet, an inductive repulsion, the normal conduction suction, a combination of the normal conductor suction and a permanent magnet, and the superconductor magnetic suspension have been studied. The initial objective is to do an experiment with a 3 ton car. In addition, design of the superconductor magnetic suspension LSM-driven railroad is being evaluated. The Soviets carefully investigate the world status of development, covering a wide range of information.

Superconductor magnetic suspension LSM-driven railroads are closely connected to low temperature. It is noteworthy that a five-year (1976~1980) project involving the research and development on low-temperature-related fields has been promoted for the tenth time.

7. CONCLUSION

Besides those major countries mentioned above, there are a few other countries that conduct research and development on railroads. In France, they have been investigating a U-shaped linear motor and demonstrated the possible use of a model set-up following the similarity principle in the electromagnetic system. Brazil has a large resource of niobium ores used as a material for the superconductor wires, and is interested in finding superconductor suspension railroads as a part of an energy saving project. In this country, they plan to use alcohol as a possible fuel for automobiles and to electrify railroads for inter-city high-speed mass transportation. In future, the superconductor magnetic suspension railroad is expected to connect cities.

We have described the current overseas status on railroad development according to major countries. Their general motivation is to take advantage of characteristics such as low pollution, high speed, and even a resource for energy. Each country appears to make all possible efforts to gain new technologies. Technologies obtained during the development stages are being applied to other areas of investigation as well. For example, they are making use of the superconductor magnetic suspension LSM-driven technology for the purpose of space transportation. (Accepted for publication 11 July 1979).

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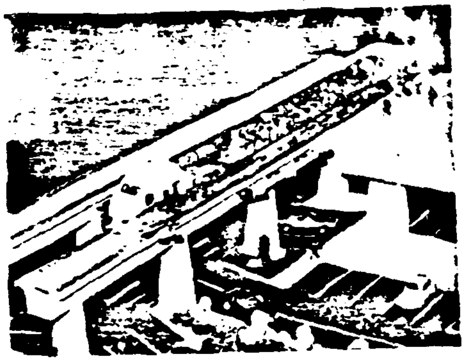

Fig. 1. A model of the superconductor magnetic suspension railroad in Canada.

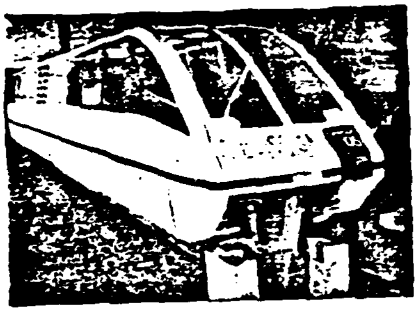

Fig. 2. IVA 79.

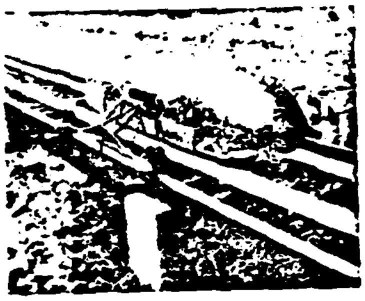

Fig. 3. An experimental set-up for the superconductor magnetic suspension system. Two aluminum sheets are used.

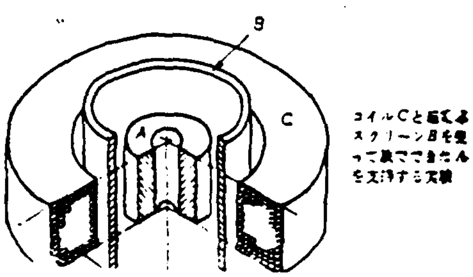

Fig. 4. A mixed μ-type magnetic system.[1] An experiment to support an iron, A, using a coil, C, and a superconducting screen, B.

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